COMMUNICATIONS SYSTEM

The present invention relates to the field of communications systems in general and to systems for protecting against the effects of equipment failure in communications systems in particular.

One of the most important concepts in network management is maintaining the survivability of networks. When there are either link or node failures any affected routes should be repaired as soon as possible. A node failure can be considered as the failure of multiple links, that is, a node failure affects the traffic the same way as if all links terminated on it were faulty. The present invention applies to both link and node diversity protection schemes: here diversity relates to the property of the resources used by the protection path (links and/or nodes) to be fully disjoint from those used by the working path.

Because of the large volumes of traffic that networks are expected to carry, resulting from the continued explosive growth of data-oriented applications, network survivability has become an issue of paramount importance. In conjunction, there is a continuing drive for maximising efficiency and minimising costs in large networks. Nodes are able to monitor the status of the connections passing through them to detect faults. In the SDH transport network, for example, this can be achieved using both trail monitoring and the so-called non-intrusive monitoring, both defined in the ITU-T specification G.783.

Traditional protection schemes, mainly used in ring networks, consume large amounts of bandwidth. Shared protection (where resources are shared between a number of protection paths) on mesh networks requires less additional capacity to provide fault protection than on ring networks. Although shared protection mesh networks consume fewer network resources, the trade-off has been in longer service restoration times. There is therefore a need for an appropriate architecture to enable fast restoration in such networks.

The present invention provides a data communications system comprising a plurality of nodes and a plurality of links for providing connections between the nodes; in which a subset of the links and nodes form a worker path for carrying worker data through the communication system; in which the system comprises a further subset of links and nodes for forming a protection path for carrying non-worker data in the absence of a fault in the worker path and for providing an alternative path for the worker data in the event of a fault in the worker path; in which the system comprises protection means, in which the alternative path is predetermined by the protection means prior to the detection of a fault in the worker path.

According to a preferred embodiment, the system comprises means for allocating the links and nodes one or more cost values relative to the links and nodes of the worker path and

means for selecting on the basis of the one or more cost values a further subset of the nodes and links to form a protection path for at least one link or node of the worker path

The present invention also provides a method of protecting a worker path in a data communications system comprising a plurality of nodes and a plurality of links for providing connections between the nodes; including the steps of passing worker data through a subset of the links and nodes making up the worker path and designating a further subset of links and nodes to form a protection path; in which the protection path carries no worker data in the absence of a fault in the worker path and provides an alternative path for the worker data in the event of a fault in the worker path.

According to a preferred embodiment, the present invention also provides a method including the steps of allocating the links and nodes one or more cost values relative to the links and nodes of the worker path and selecting on the basis of the one or more cost values a further subset of the nodes and links to form a protection path for at least one link or node of the worker path..

CLAIMS

1. A data communications system comprising a plurality of nodes and a plurality of links for providing connections between the nodes;

in which a subset of the links and nodes form a worker path for carrying worker data through the communication system;

in which the system comprises a further subset of links and nodes for forming a protection path for carrying non-worker data in the absence of a fault in the worker path and for providing an alternative path for the worker data in the event of a fault in the worker path;

in which the system comprises protection means, in which the alternative path is predetermined by the protection means prior to the detection of a fault in the worker path.

2. The system according to Claim 1 in which the protection means is arranged to activate the entire protection path to carry the worker data upon detection of a fault in the worker path.

3. The system according to Claim 2 in which the protection means is arranged to identify the location of the fault and to return the worker data to those parts of the worker path not affected by the fault.

4. The system according to Claim 2 or 3 in which the protection means is arranged to de-activate any links or nodes of the protection path that are not needed to provide a path for the worker data.

5. The system according to any above claim, in which the nodes of the further subset comprise storage for storing the details of the protection path prior to the detection of a fault in the worker path.

6. The system according to Claim 5 in which the details of the protection path are associated with a unique path identifier.

7. The system according to Claim 5 or 6 in which each of the nodes of the further subset comprise a protection table for storing details of the protection path.

8. . The system according to any above claim, in which at least one of the nodes common to both subsets comprises means for detecting a fault in the worker path and means to activate the protection path by sending an activate message to the nodes of the further subset upon detection of the fault in the worker path.

9. . The system according to Claim 8 in which in which the nodes comprising means for sending the activate message also comprise means for sending the activate message to each adjacent node of the further subset.

10. . The system according to Claim 8 or 9 in which the activate message contains a unique path identifier to inform the nodes of the further subset which connections to activate.

11. The system according to any above claim, in which the nodes comprise means for detecting the location of a fault in the worker path and means for, upon detection of the fault location, sending a deactivate message through the first subset in the direction away from the fault.

12. The system according to Claim 11 in which each node comprises means for detecting receipt of the deactivate message and upon receipt of such a message, to deactivate any path passing from that node via nodes of the further subset where those paths do not form an protection path to the faulty part of the worker path.

13. A method of protecting a worker path in a data communications system comprising a plurality of nodes and a plurality of links for providing connections between the nodes; including the steps of passing worker data through a subset of the links and nodes making

up the worker path and designating a further subset of links and nodes to form a protection path; in which the protection path carries no worker data in the absence of a fault in the worker path and provides an alternative path for the worker data in the event of a fault in the worker path.

14. The method according to claim 13 including the steps of detecting a fault in the worker path and activating the entire protection path to carry the worker data upon detection of a fault in the worker path.

15. The method according to claim 14 including the steps of identifying the location of the fault and returning the worker data to those parts of the worker path not affected by the fault.

16. The method according to claim 14 or 15 including the steps of de-activating any links or nodes of the protection path that are not needed to provide a path for the worker data.

17. The method according to any of claims 13 to 15 including the steps of storing the details of the protection path in the nodes of the further subset prior to the detection of a fault in the worker path.

18. The method according to claim 17 including the steps of associating the details of the protection path with a unique path identifier.

19. The method according to claim 17 or 18 in which each of the nodes of the further subset comprise a protection table for storing details of the protection path.

20. The method according to any of claims 13 to 19 including the steps of at least one of the nodes common to both subsets detecting a fault in the worker path and activating the protection path by sending an activate message to the nodes of the further subset upon detection of the fault in the worker path.

21. The method according to claim 20 including the step of the nodes sending the activate message sending it to each adjacent node of the further subset.

22. The method according to any of claims 20 to 21 including the step of including a unique path identifier in the activate message to inform the nodes of the further subset which connections to activate.

23. The method according to any of claims 13 to 22 including the steps of at least one node detecting the location of a fault in the worker path and, upon detection of the fault location, sending a deactivate message through the first subset in the direction away from the fault.

24. The method according to claim 23 including the steps of the nodes detecting receipt of the deactivate message and upon receipt of such a message, deactivating any path passing from that node via nodes of the further subset where those paths do not form a protection path to the faulty part of the worker path.

25. The method according to any of claims 13 to 24 comprising a plurality of nodes and a plurality of links for providing connections between the nodes; including the steps of allocating the links and nodes one or more cost values relative to the links and nodes of the worker path and selecting on the basis of the one or more cost values a further subset of the nodes and links to form a protection path for at least one link or node of the worker path.

26. The method as claimed in claim 25 including the steps of selecting the subset that has the lowest cost value.

27. The method as claimed in claims 25 to 26 including the steps of setting the one or more cost values for nodes and links on the worker path other than the at least one node or link to be protected lower than the cost value for other nodes and links.

28. The method as claimed in claim 27 in which the lower cost value is zero.

29. The method as claimed in claim 25 to 28 including the steps of setting the one or more cost values for the at least one node or link to be protected higher than the cost values for other nodes and links.

30. The method as claimed in claims 25 to 29 including the steps of setting the one or more cost values for the at least one node or link to be protected so that that node or link will not be selected.

31. The method as claimed in claims 25 to 30 in which the data communications system comprises a further worker path and protection for the further worker path.

32. The method as claimed in claim 31 including the steps of setting the one or more cost values relative to the worker path of a node or link to an intermediate value, provided that the nodes and/or links on the worker path and on the further worker path for protection by that node or link have no common point of failure.

33. The method as claimed in claim 32 in which the intermediate value lies between the higher and lower values.

34. The method as claimed in claim 33 including the steps of setting the one or more cost values relative to the worker path of a node or link to a higher value so that node or link will not be selected, if the nodes and/or links on the worker path and on the further worker path for protection by that node or link have at least one common point of failure.

35. The method as claimed in claims 25 to 34 including the step of allocating each link and node one or more cost values relative to each link and node of the worker path.

36. The method as claimed in claims 25 to 35 including the steps of determining the protection path prior to the detection of a fault in the worker path.

37. The method as claimed in claims 31 to 36 including the steps of allocating the links and nodes a further cost value relative to the further worker path and selecting on the basis of the further cost value a further subset of the nodes and links to form the protection path for at least one link or node of the further worker path.

38. The data communications system of claims 1 to 12 in which the system comprises means for allocating the links and nodes one or more cost values relative to the links and nodes of the worker path and means for selecting on the basis of the one or more cost values a further subset of the nodes and links to form a protection path for at least one link or node of the worker path.

39. The system as claimed in claim 38 comprising means for selecting the subset that has the lowest cost value.

40. The system as claimed in claims 38 to 39 comprising means for allocating nodes or links on the worker path other than the at least one node or link to be protected a cost value lower than the cost value for other nodes and links.

41. The system as claimed in claim 40 in which the lower cost value is zero.

42. The system as claimed in claim 38 to 41 comprising means for allocating the at least one node or link to be protected a cost value higher than the cost value for other nodes and links.

43. The system as claimed in claims 38 to 42 in which a cost value for the node or link to be protected is set so that that node or link will not be selected.

44. The system as claimed in claims 38 to 43 comprising further subsets of the nodes and links for forming both a further worker path and a protection path for the further worker path.

45. The system as claimed in claim 44 comprising means for allocating to a node or link one or more intermediate cost values relative to each link and node of the worker path provided that that link or node in the worker path and the links and nodes in the further worker path protected by the node or link have no common point of failure.

46. The system as claimed in claim 45 in which the intermediate value lies between the higher and lower values.

47. The system as claimed in claim 46 comprising means for allocating to a node or link one or more higher cost values relative to the at least one link or node of the worker path so that that node or link will not be selected where the links and nodes in the worker path and links or nodes in the further worker path protected by the node or link have a common point of failure

48. The system as claimed in claims 38 to 47 including means for allocating the links and nodes a cost value relative to each link and node of the worker path.

49. The system as claimed in claim 38 to 48 in which the system comprises protection means for determining the protection path prior to the detection of a fault in the worker path.

50. The system as claimed in claims 43 to 49 comprising means for allocating the links and nodes a further cost value relative to the further worker path and for selecting on the basis of the further cost value a further subset of the nodes and links to form the protection path for at least one link or node of the further worker path.